Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

June 1950 AIC-274

PRODUCTION OF A FRIABLE MEAL FROM FEATHERS

Charles H. Binkley and Otto R. Vasak
Western Regional Research Laboratory, Albany 6, Calif.

Experiments in which fresh waste feathers were treated by steam-pressure cooking and drying have yielded a friable, easily handled, stable meal. Analytical and cost studies, along with a limited commercial processing trial, indicate that the product is commercially feasible as a component of mixed fertilizers. Other uses--as a plaster retarder or as fire-control foam agent--have appeared possible in preliminary investigations. Information on the process, the product, and probable cost of manufacture is included in this report.

Bureau of Agricultural and Industrial Chemistry
Agricultural Research Administration
UNITED STATES DEPARTMENT OF AGRICULTURE

Production of a Friable Meal from Feathers

Industrial attempts to calcine feathers, by methods and for purposes similar to those applicable to hoofs and horns, have usually resulted in operational difficulty or excessive processing cost. At present packers of fresh, frozen, or otherwise processed poultry must rely on methods of disposal of feathers that entail costs and yield no salable product. Recent experiments at this Laboratory have revealed a practical process for treating waste feathers that yields a product having apparent commercial value, and a commercial test has substantiated the findings of laboratory trials.

Feathers in large amounts, estimated to be about 40,000 tons annually, are available at poultry dressing plants. This figure represents approximately 25 percent of all the feathers from poultry processed on farms, in homes, and by dressing plants. Because of their concentration, feathers from the dressing plants constitute a disturbing disposal problem. As the industry becomes more centralized the problem will become more acute. On the other hand, greater centralization makes the feathers more readily available for utilization

Process

The process developed in recent studies in this Laboratory is as follows: Feathers are treated in a cooker with saturated steam at gage pressures of 40 to 60 psi. (287°-307°F.) for 30 to 60 minutes. To obtain uniform heating, the feathers are agitated during cooking. Next the steam is exhausted, and the treated feathers are transferred to suitable drying equipment, where they are dried to a moisture content of 8 to 12 percent. The dry, friable material is easily ground to produce a meal or powder suitable for packaging in such containers as multi-wall paper bags.

Either wet or dry feathers can be treated by the process. Dirt in the raw material appears in the final product but does not affect the processing of the feathers. Wet feathers, as they are taken from the pickers, are convenient for treatment because of their small volume per pound as compared with dry feathers. Decomposed feathers should be avoided, because they tend to gum during cooking at lower temperatures than fresh feathers and yield a product of lower nitrogen content. Under normal conditions the feathers should not be left in piles more than three or four days before they are processed.

Heating the feathers in the cooker is accomplished by bringing live steam into direct contact with the feathers. The heating time required to obtain a satisfactory product increases rapidly as the steam gage pressure is lowered below 40 psi. (287°F.). When pressures above 60 psi. (307°F.) are used, extreme care must be exercised to prevent gumming of the feathers. At 80 psi. (324°F.) it is difficult to avoid gumming of the product. If the feathers gum, it is difficult or impossible to discharge or to dry the material unless it is heated until the entire mass is charred, dry, and brittle. This may require heating at 80 psi. gage for 4 hours. Gumming causes an increase in power consumption for mixing and makes the cooker difficult to clean.

A good product is easily made when the feathers are heated at 40 psi. gage for 1 hour or 60 psi. gage for a half hour. From the standpoint of operating costs, heating at 60 psi. for the shorter time is preferable. It is recommended, however, that initial plant runs be conducted at 40 psi. gage for 1 hour. After a satisfactory product is made and the process is thoroughly understood, treating temperatures can be gradually increased with successive runs until the upper operating limit is reached. This procedure is recommended as a precaution against gumming.

Loss of product by volatilization during cooking is negligible and is limited to small amounts of sulfur and nitrogen. The initial and final nitrogen analyses are essentially the same when cooking is done under the conditions outlined above.

Equipment and Investment

Equipment required to carry out receiving and storage operations may consist of hoist and crane, steel storage bin for wet feathers, and miscellaneous hand tools.

A cooker such as is used in the dry-process rendering of waste fats and meat scraps operates well for the feather process. The cooker should be equipped with vanes or paddles for agitating the feathers. There must be suitable openings for loading and discharging of the cooker. In order to bring the feathers to their cooking temperature quickly, provision should be made for the rapid introduction of steam into the feather mass. Provision for the rapid exhaustion of steam will permit removal of a larger proportion of water present when the batch is to be discharged. Suitable pressure gages, temperature indicators, and valves are required for careful control of the process.

The product discharged from the cooker can be dried in a rotary drier of the steam-tube type. The feathers can be dried with the application of vacuum in the cooker if it is of the jacketed type. This practice is not recommended, however, unless the cooker is of small capacity. In small cookers the savings in handling costs would probably more than offset higher drying costs. Fineness of grind of the treated feathers will depend on the user's requirements and on product specifications. Generally, either a grist mill or a hammer mill is satisfactory for the grinding operation.

The probable installed cost of equipment capable of handling a maximum load equivalent to 10 tons of dry feathers per 24-hour day is given in the following table:

Manufacturing step	Estimated cost of installed equipment for the steam treatment of feathers
Receiving and storing	$ 3,500
Processing	42,000
Packaging	4,500
Total installed equipment cost	$50,000

These approximate costs would constitute the major investment requirement of prospective feather processors who already have surplus building space for the equipment installation and an ample steam supply. If steam is not available from existing sources, an investment of about $5,000 would be required for the purchase and installation of a suitable "packaged" steam-generating unit.

An additional investment for building and land would be needed if new construction is necessary to furnish floor area for feather processing. In determining the building investment it was estimated that a one-story building with approximately 3,400 square feet of floor area would be satisfactory. It was assumed that construction costs would be about $6 per square foot.

Additional investment	Approximate cost of building and land for the steam treatment of feathers
Building	$20,000
Land	5,000
Total building and land investment	$25,000

The approximations above are intended to serve only as a guide, since building costs vary considerably with locality and type of construction. A total investment of about $80,000 would be required to construct and newly equip a self-contained plant capable of processing the equivalent of 10 tons of dry feathers per day.

Total Processing Costs

Preliminary estimates show that processing and packaging costs incurred in the steam treatment of feathers amount to approximately $34 per ton of product. The following table shows a cost breakdown by manufacturing step and by major cost component.

Estimated processing and packaging cost per ton of steam-treated feathers

Manufacturing step	Factory burden 1/	Labor 2/	Materials 3/	Total
Receiving and storing	$ 1.00	$ 1.70	$....	$ 2.70
Processing	12.60	9.60	2.60	24.80
Packaging	1.10	2.40	3.00	6.50
Total	$14.70	$13.70	$5.60	$34.00

1/ Factory burden includes depreciation, interest on investment, and working capital, taxes and insurance, utilities, repair and maintenance, and plant overhead..
2/ Labor includes wages and salaries and labor expenses.
3/ Materials include either oil or gas for steam generation and packaging supplies.

These figures are based upon the assumption that a self-contained plant would process the equivalent of 10 tons of dry feathers per 24-hour day during 4 months of the year, and the equivalent of 5 tons of dry feathers per 16-hour day during the remaining 8 months of the year. The estimate was based upon a variable supply of feathers, because this condition would probably exist in most poultry-processing areas. For the purpose of calculating equipment sizes for this analysis it was assumed that 1 gallon of wet drained feathers weighs 3.6 pounds and represents 1.2 pounds of dry feathers (8 percent moisture).

There are several ways of reducing both investment and processing costs. If the feather process is installed as a side line in an established industrial plant, the use of common supervision, available storage space, existing utilities, and other facilities would result in some savings. Stack gases or waste steam might be used to operate the rotary drier.

Constant operation at full capacity would also lower processing costs. The required investment could be cut down considerably if the process were used by a rendering plant to utilize idle equipment. This application of the process may be the most logical.

Product

The dry, ground product resulting from the steam treatment of feathers weighs 52-60 pounds per cubic foot. It can be used directly as a conditioning agent in mixed organic fertilizers, or as a source material for the preparation of a plaster retarder. It has water-insoluble nitrogen activity well above that required of organic fertilizers. Analytical data for processed feathers containing 12 percent moisture are as follows:

	percent
Total nitrogen	12.1-13.6
Water-insoluble organic nitrogen	9.8-13.1
Water-insoluble organic nitrogen soluble in neutral $KMnO_4$	9.5-12.8
Active water-insoluble organic nitrogen distilled from alkaline $KMnO_4$	6.6- 7.9
Activity water-insoluble nitrogen:	
Alkaline $KMnO_4$ method	67.3-60.3
Neutral $KMnO_4$ method	96.9-97.7

Other potential uses are indicated by its protein properties and its amino acid content.

The special values of the product as fertilizer consist in its effectiveness as a conditioning agent for inorganic mixed fertilizers and in its slow release of nitrogen. As a conditioning agent it prevents the caking of inorganic fertilizer salts by absorption of moisture, thus permitting uniform spreading of the mixed fertilizer. The slow release of nitrogen is an advantage for greenhouses, lawns, and other applications where a steady supply of nitrogen is required. This property is indicated by the analysis above and has been demonstrated in use tests. In general the nitrogen in organic fertilizer commands about twice the

LIBRARY
Current Serial Record
MAR 8 1950
U. S. DEPARTMENT OF AGRICULTURE

price of inorganic fertilizer nitrogen. On the current fertilizer market, the feather product would probably command a price of about $60 per ton, with variation due to nitrogen content of the product and locality of sale.

The material can be used in the preparation of plaster retarders. For this use the feather product has essentially the same characteristics as hoof meal, which sells for about $130 per ton on the current market.

Another potential use for the feather product is in the preparation of a fire-control foam compound. No immediate outlet for such use is known, however. The feather protein would compete in this use with other proteins.

There is a possibility that the feather product can be used as a feed component. Such use would depend on extensive feeding studies. The product is relatively high in arginine, one of the amino acids considered essential for the feeding of poultry. Used as a poultry feed component the material would probably command a higher price than as a component of fertilizer.

Summary

The product resulting from the steam treatment of feathers can be used as an organic fertilizer, a mixed fertilizer component, or in the preparation of a plaster retarder. It has potential uses as a feed component and as a source of protein material in the manufacture of a fire-control foam compound. The product can be prepared by treating fresh waste feathers in a dry-rendering type of cooker with saturated steam for 30 to 60 minutes at gage pressures of 40 to 60 psi. (287°-307°F.) and then drying and grinding the cooked feathers. The processing and packaging costs incurred in the manufacture of the material are estimated to be about $34 per ton of product. This processing and packaging cost does not include the cost of collecting feathers, nor does it consider the costs that might be incurred in marketing the product. The process appears to have attractive economic possibilities, and its application will help to alleviate the waste problem in poultry dressing operations.